TECH ENGINEERING NEWS
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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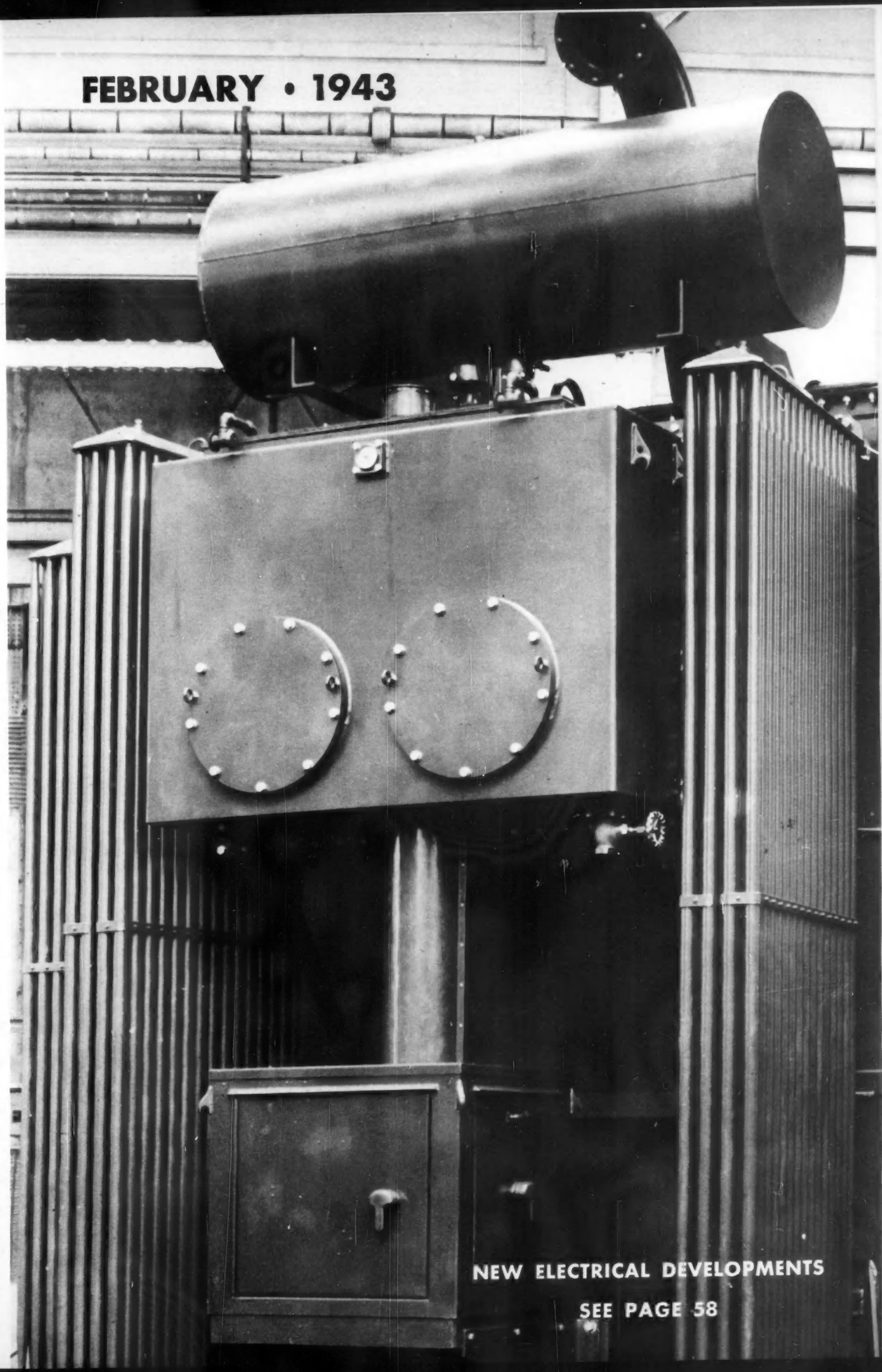

NEW ELECTRICAL DEVELOPMENTS

SEE PAGE 58

Information supplied by an Industrial Publication

Single-cylinder aircraft-engine test stands in one aircraft engine plant are helping to speed production, while contributing to improvement in engine parts, and, consequently, to power plant performance.

These stands duplicate a regular, full-sized, 9 cylinder radial engine, except that eight of the cylinders have been removed and the drive shaft, instead of spinning a propeller, exerts its force against a brake mechanism for registering horsepower. With these single cylinders, engineers run tests on pistons, spark plugs, valves, piston rings, piston pins, intake and exhaust ports and cooling fins. Tests of hundreds of variations and combinations are run quickly, saving not only the expense of operating a complete engine, but also valuable days of test time, and releasing the regular test cells for production use on full-sized engines. In addition, a test on a specific part can be run to the point of failure with the single-cylinder stands.

Design features in the cylinder and its component parts can be tested, modified, rejected, improved or approved before constructing a full-scale engine model for extensive ground and flight tests. Also, troubles cropping up in service engines can be relentlessly pursued.

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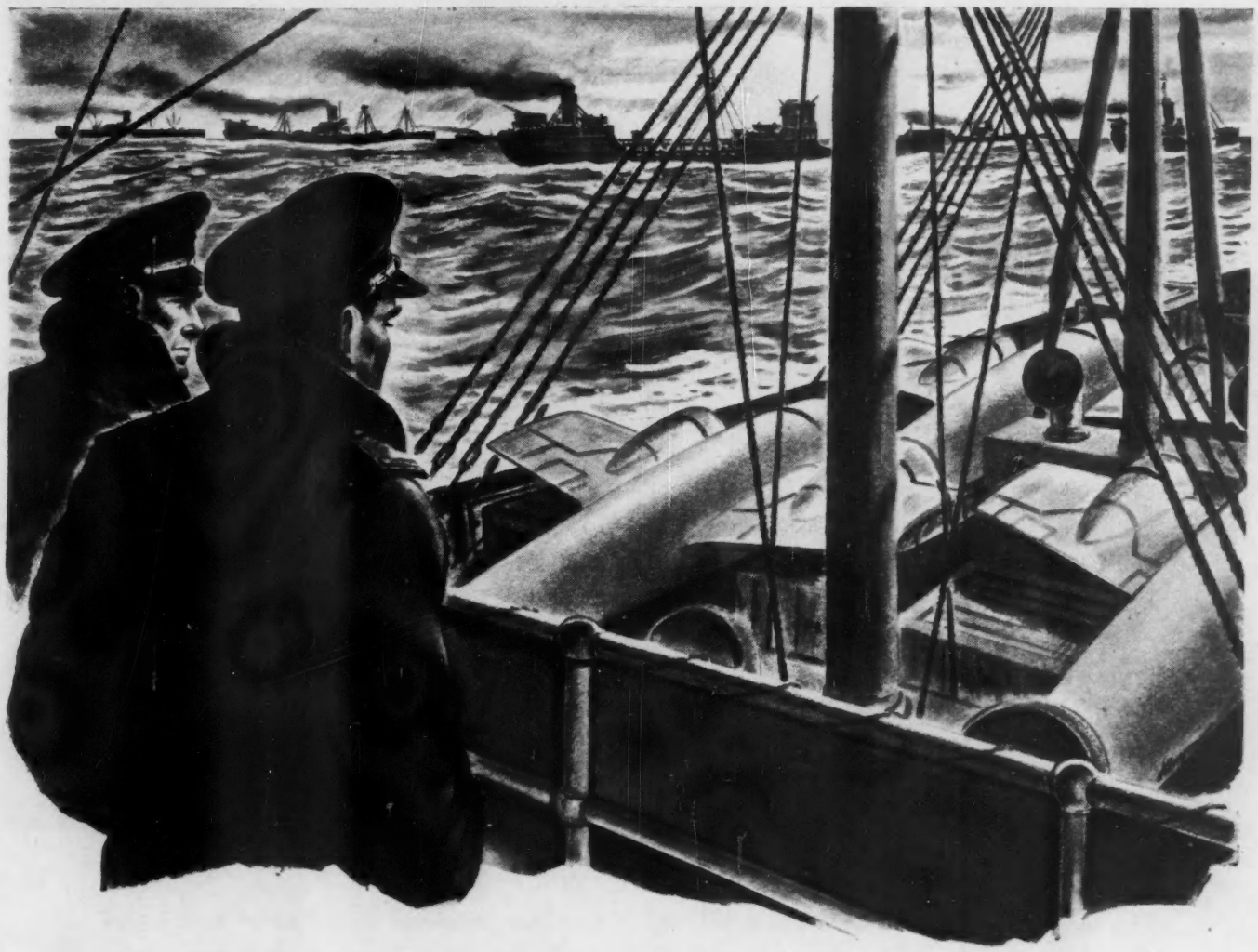

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In 1918, an American soldier could be equipped and maintained on 5 tons of supplies each year.

But today, for every soldier sent abroad, *10½ tons* of shipping space must be provided for *equipment alone.* And it takes an additional *18 tons of shipping to supply a single soldier for a year!*

Supply is a matter of *ships.*

And ships need electricity.

Vast quantities of electric power, for a thousand vital tasks that must be done to take a convoy safely across the seas...

Electricity to steer the vessels and operate the radios and signal lights.

Electricity to detect the approach of enemy subs and planes, to sound the alarm, to organize the defense.

Electricity to power great cargo winches, and delicate navigating instruments.

Electricity to make magnetic mines harmless, to provide invisible "black light" for reading charts at night. Electricity to keep food fresh, to cook it, to ventilate the ships, to provide comfort for the crews.

Electricity in every freighter, every tanker, every Navy escort vessel—to help win the war of supply!

We of Westinghouse take tremendous pride in building so much of the electrical equipment, so many of the great turbines and gears and electric drives, for the ships of America's Navy and Merchant Marine.

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Tune in the Westinghouse Program starring John Charles Thomas — NBC Network, Sunday, 2:30 P. M., Eastern War Time.

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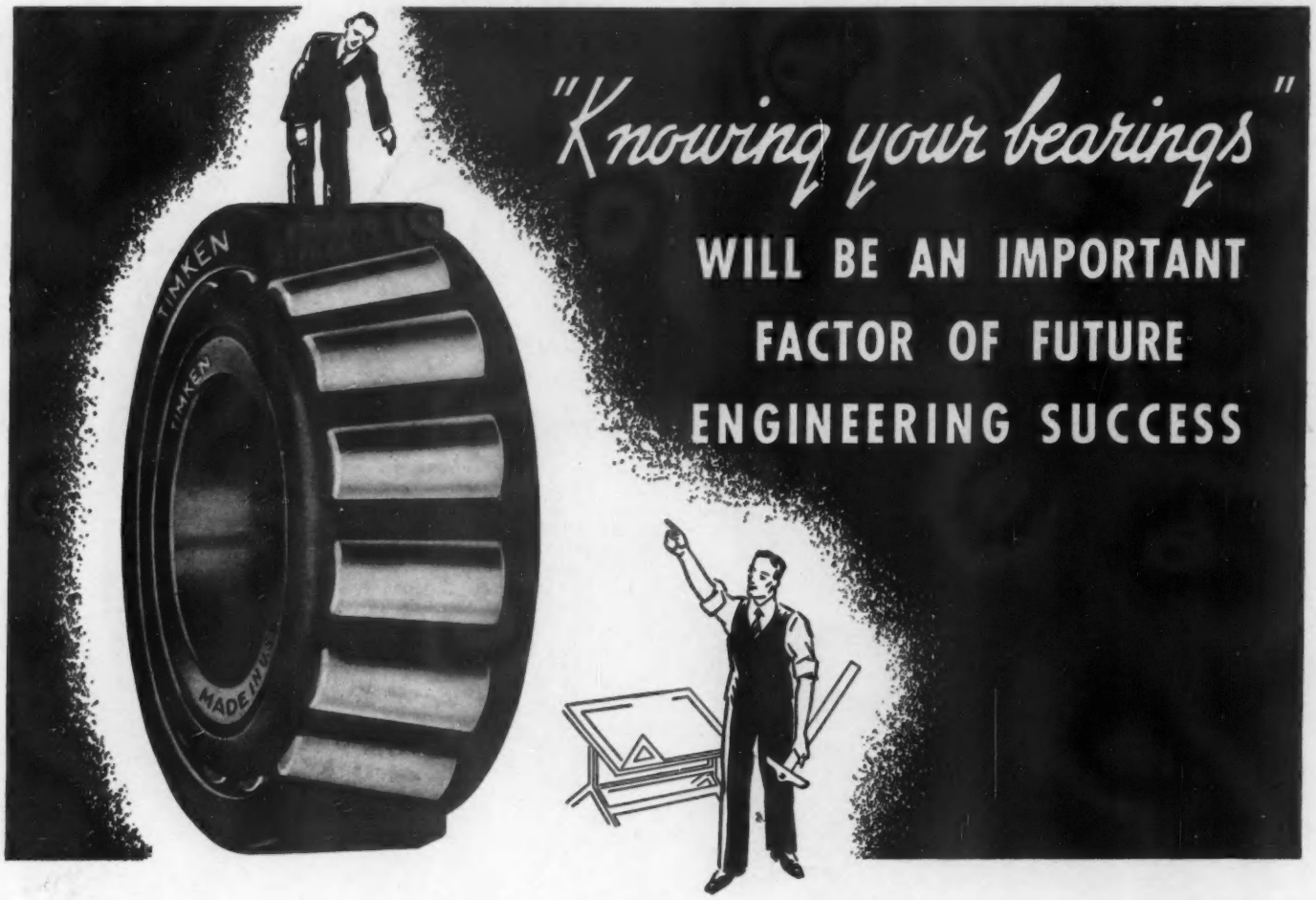

The terrific strain of modern war is testing American mechanical equipment of all kinds as it never has been tested before, but it is coming through with flying colors.

For, among other vitally important things, the designers of this equipment *know their bearings;* that is why so many Timken Tapered Roller Bearings are used in tanks, trucks, armored cars, guns, airplanes, warships and the machines that make them. Timken Bearings meet every bearing requirement because, in addition to eliminating friction they carry radial, thrust and combined loads and hold moving parts in correct and constant alignment.

Timken Roller Bearings have been solving bearing problems in industrial and transportation equipment for many years—long before the first world war. They will be called upon more and more during the reconstruction period that will follow Victory for the United Nations in the present conflict.

That is why you should begin now to acquire a thorough knowledge of Timken Tapered Roller Bearings — their design and application. When you have this knowledge you will be able successfully to meet any bearing condition you ever may encounter. Our engineers will help you to get it. The Timken Roller Bearing Company, Canton, Ohio.

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THE TECH ENGINEERING NEWS

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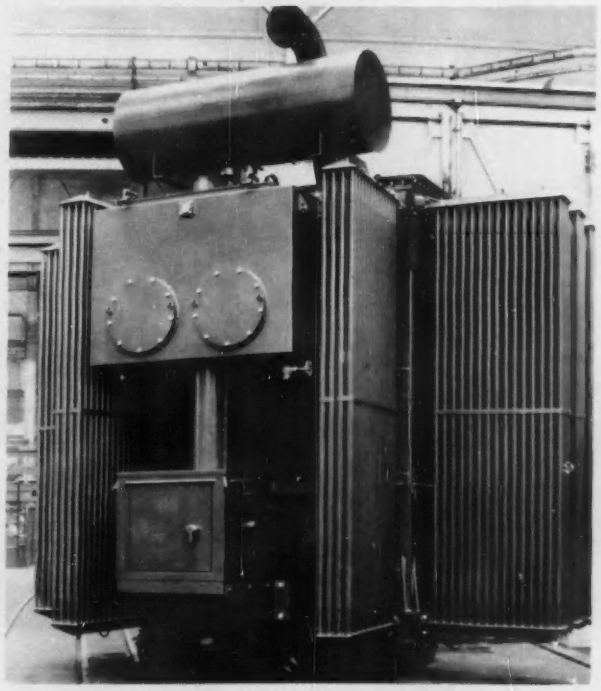

General Electric Company

Autotransformer for electrolytic cell line, 27,950 kva. Permits d-c voltage adjustment of plus or minus 60 volts by tap changing under load, and d-c voltage adjustment between zero and 650 volts d-c by no-load tap changer.

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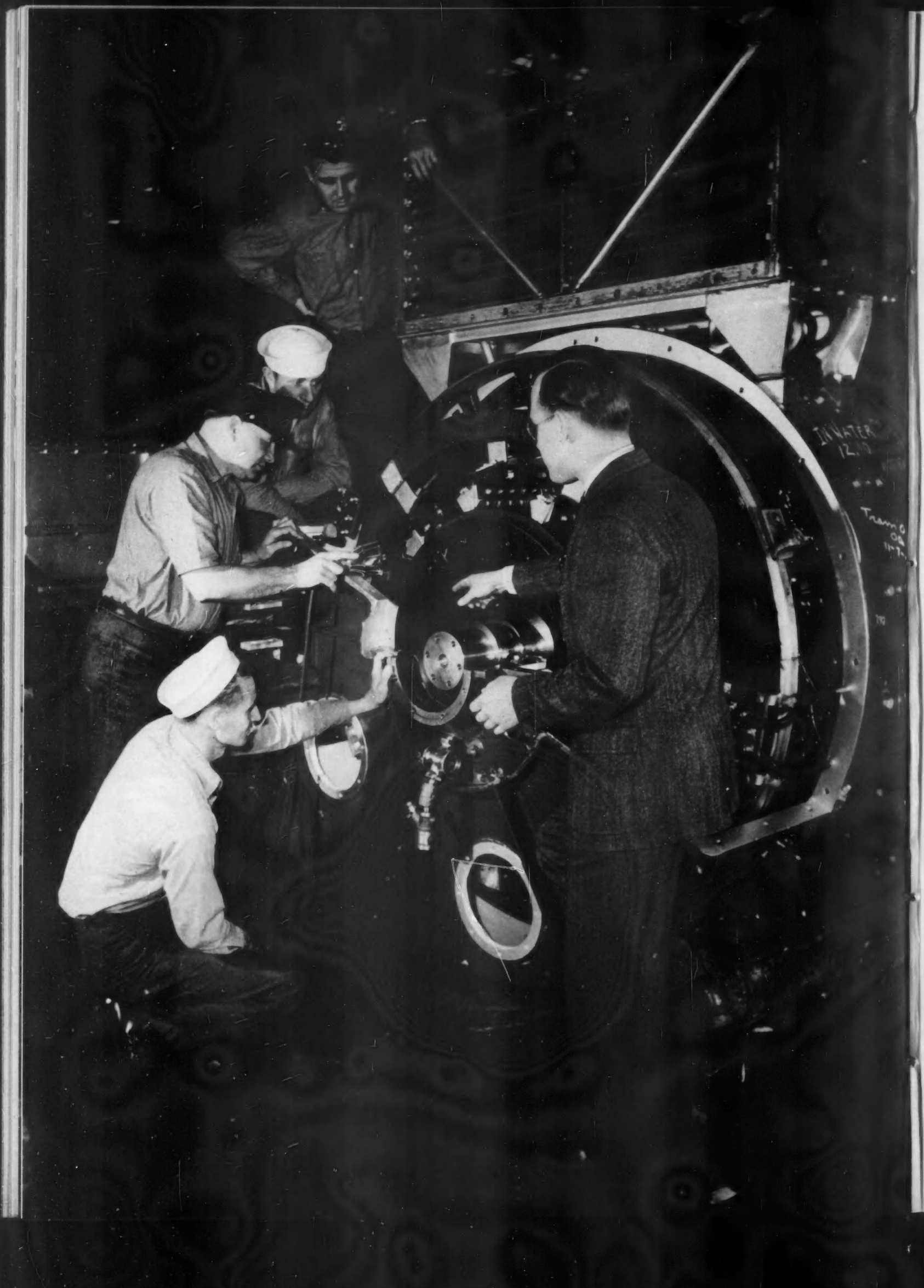
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THE ENGINEERING BEHIND MICKEY MOUSE

ANIMATED MOTION PICTURE PRODUCTION MEANS SURMOUNTING MANY TECHNICAL DIFFICULTIES

By WILLIAM HOSIE

THE methods followed in producing an animated motion picture are basically simple. The degree of their success depends largely upon the care and attention given to detail. The picture is built up frame by frame of film, and any tendency to overlook detail is reflected in the finished product. When one realizes that roughly 900,000 drawings are seen in a feature like "Bambi," it becomes clear why such great care must be exercised by all the production departments in the studio.

Just a few years ago, short productions of some seven to ten minutes made up the total output of animated cartoons. Later, although still expending as much care as ever on the shorts delivered to the distributor, full-length productions held a large share of the spotlight. Today, approximately 90 per cent of the studio is engrossed in the production of training films for the Army and Navy and films for various other governmental departments. A peace-time year's production of 30,000 feet of animation has been boosted to this year's war-time production level of 300,000 feet — a feat which was believed impossible in the past.

Gone are the days when the personnel of a dozen or so men worked out the details of a picture sitting around a lunch table. Now each full-length production has its production supervisor and at least a half dozen directors, each with his complete unit. Such a unit is assigned several sequences of a full-length production, and it is up to the unit director to see that his sequences move along smoothly. Working with a director is his immediate crew, consisting of assistants, story sketch men, artists who plan staging and the action, create the proper moods, and work out camera angles; and the artists who execute the planned backgrounds. Beside this personnel, which works alongside the director in the same suite of rooms, are the animators assigned to this director's sequences.

The animation building, which is the heart of the whole plant, is three stories high, and was built to conform with the working plan. On the third floor are all departments concerned with a story's inception. When a story is "tightened," it is moved down to the second floor where its sequences are divided up among several directors. From his unit each director "hands out" scenes to designated animators, all of whom are on the first floor. When animation is completed the story moves out of the animation building into the inking and painting and camera buildings for completion.

William Hosie is a former New York newspaperman, play critic, and political and club publicist. Now a staff writer with the Walt Disney Studios, he is expecting an early call to the armed forces.

This, in a very small nutshell, is the progress of an animated cartoon. Of course, there are many more "ins and outs" to the whole process.

For instance, much more happens in a director's unit than just handing out work to the animators. When a director receives sequences of a feature picture to do, he is assigned his certain sequences on the basis of his natural aptitude for them. For instance, some directors are good at handling powerful dramatic action, while others are best at broad comedy. Others naturally take to musical sequences or to subtle action.

As soon as story sequences are moved to a director's unit, he goes over them for whatever additions, deletions, or changes he thinks should be made. His story sketch men are there to sketch up new ideas. At this stage of the game an entire sequence is done in succeeding sketches and the sketches pinned up on a large board.

In order to catch the overall mood of the sequence, the final story sketches are photographed and made into a reel, complete with tentative dialogue and sound effects.

While the directorial crew is working on making the basic action and "business" of the sequences as fine as possible, the musician assigned to write for that particular feature is working closely with them where the songs and score are concerned. Sound effects are being planned, worked out and recorded. Tests for characters' voices are constantly carried on until the right voice is found. Animators are working closely with the director in planning exactly what the characters' actions will consist of — down to the last facial expression and gesture. The layout men are in this continuous huddle too, planning the backgrounds and the relationship of the characters' actions to the background. It is also his job to plan the camera shots. In other words, if he thinks it will be more effective to plan a scene so that the characters are seen from the roof of a house, such plans are worked out, and the animator therefore draws his characters to that perspective.

When the voices and music are set, the animator is ready to begin his actual work. Animators, incidentally,

United States Navy petty officers study apparatus for a submarine
General Electric Company

Walt Disney Studio

Former top-notch animator Norm Ferguson, now a producer-director, animating on the famous character Pluto

are cast just like actors. Some are good at drawing little compact "cute" characters; some shine at pretty girls; some like to do villains; and others can create good slapstick. An animator is given a chart on which the music and dialogue are broken down into film frames so that he can see exactly how many frames of film each syllable or note takes up. In this way he can animate his character right in synchronization. When he finishes all of the successive drawings which make up a scene, he sends them to be photographed. He then runs the resultant film to see that the scene is as he wanted it. If it is, and if it is acceptable to all concerned, it is put into a regular reel. As the scenes of other animators working with the unit are finished and accepted, they are put into the reel too, until finally the entire sequence is there in the rough.

Meanwhile other things are being done, too. A color coördinator has, with the coöperation of the directors, layout men and representatives from the painting department and paint laboratory, set the colors for the entire production. Thus backgrounds are being painted, and girls in the color model department are making up model celluloids on the characters as a double check.

New technical improvements in animated cartoon production during the past year or two have been largely centered in camera developments. On the payroll at all times is a crew of engineers who do nothing but camera research.

The new plant at Burbank has eight times more room for housing the camera department than the previous set-up. New multiplane cameras have been constructed — with six levels, one more than the original multiplane crane, and with a field range twice as big. Another added feature in the new work on multiplane cameras is an increased depth of focus, the new lighting capable of a maximum of 20,000 watts of light per camera plane, as against 2,000 watts on the older camera.

Improvements have also taken place on the standard cameras — those of just one level. The magazine has been changed to the top side of the crane. Formerly all cameras were standard motion picture cameras adapted for cartoon work. Now the technicians have redesigned all cameras so that they are entirely ideal

Several background artists working on backgrounds for a feature production *Walt Disney Studio*

for animated picture photography, where all scenes are photographed vertically.

The past few years have also seen work steadily progressing on a switch from nitrocellulose film to acetate film, which is slow-burning, rather than the highly combustible film of the past. This has meant that all the studio paint formulas had to be changed to conform. Other paint laboratory improvements included enlarged quarters and new equipment. As a matter of fact, the studio feels that progress in the paint laboratory has tripled over the past few years. Paints have been improved in matters of color and shade uniformity, texture and brilliance. Paints used in water effects and as shadows have been especially improved.

So it goes. Little by little, what might look like widely scattered jobs are gradually converging toward a central point. When that central point is reached, the picture is done.

A lot of work? Of course it is a lot of work. Everybody in each department must do his work with as much perfection as he can muster in order that the final result is suitable.

We are sure that the animated feature production is here to stay. In fact, the sureness of the fact was so great that an entirely new studio was built to accommodate the future full-length production plans.

The surface of the animation medium has only been scratched. It is capable of doing things that other entertainment mediums, because of certain physical limitations, find impossible.

The combination of two art forms — music and pictures — in "Bambi" is a case in point. The obstacles overcome in "Bambi" helped tremendously in the new field in which the studio now finds itself — the field of visual education — in the making of training films for the Army and Navy and in the psychological and goodwill films being made for various other branches of our Government.

This new field which is capable of new and exciting possibilities will be thoroughly exploited in the post-war era to the advantage of the whole world, which will practically have to learn to live a complete new life with drastic changes.

Walt Disney Studio

The famous Multiplane Camera in production with inking and painting checkers checking the cells before insertion on the particular camera level by camera men. The Multiplane Camera with its various levels gives the dimensional "feeling" seen in cartoon feature productions.

A view of the Sound Effects Department in production working on the effects for a picture Every type of gadget and various instruments are used in this work

Walt Disney Studio

PROJECT ADMINISTRATION IN THE RESEARCH LABORATORY

HOW AN IMAGINARY PROJECT MIGHT BE MANAGED IN ONE OF AMERICA'S MODERN LABORATORIES

By HOWARD F. HAMACHER

AMERICAN corporations spent some $300,000,000 for industrial research in 1940 and realized from this investment a return which, although not precisely measurable, was undoubtedly far greater than the expenditure. The direction of this expenditure so that it will eventually be reflected in expanded sales and profits rather than in an accumulation of interesting but useless data books is the job of research management.

There are, of course, a number of phases of the general problem of research administration; most of these constitute the problems of the research director and some go beyond him to the top management of the corporation. Of these phases, only one, the administration of the single project in the laboratory, together with a brief sketch of the typical organization, will be discussed here. Before a project can come into being there are a host of problems involved in the relations of the laboratory to the rest of the company, in laboratory organization and in the selection of projects. And beyond the problems of the individual project the director must give thought to personnel administration, keeping within his financial budget, the advisability of publishing scientific papers, and many other questions.

The "glassware" stage of research — *Arthur D. Little, Inc.*

Howard Hamacher was born on September 18, 1915, in Marshalltown, Iowa. He graduated in 1936 from the California Institute of Technology with a B.S. degree in applied chemistry. After working one year in the American Smelting and Refining Company in Selby, California, he attended the Harvard Business School and received a master's degree. He worked two years with Arthur D. Little, Inc., and then returned as a research assistant in the Harvard School. A year later he became the New England Regional Representative of the Chemicals Branch of the OPA. During the last months he has been working again for Arthur D. Little, Inc.

Laboratory Organization

A research laboratory may range in size from a personnel of six or so to nearly three thousand. The most common size at present has some seventy-five to a hundred technical workers. These seventy-five to a hundred persons are differentiated both as to field of skill and as to the degree of responsibility which they can successfully discharge; laboratory organization is based on this differentiation. At the head of the laboratory is a director; beneath him there are usually a number of departments, the number and formality of organization of which will depend on the size of the company and the diversity of its operations. These divisions may be organized on product lines, that is, with the work of one division devoted to a particular class of the company's products, or along functional lines, with one division responsible for coöperation with the sales department on customer problems and another for specialized work such as physical testing or microscopic observation. Usually the organization of the divisions is based on a mixture of both these methods and has evolved over a period of years in response to the type of work which the laboratory normally encounters. These divisions may be informal in the sense that no

[1] The author wishes to express his thanks for the assistance of Mr. Raymond Stevens, Vice-President of Arthur D. Little, Inc., in the preparation of this article.

specific names or titles exist but in the laboratory of moderate size such differentiation will usually be found to have developed by the specialization of particular individuals.

The division may have a man formally designated as its head, and probably will in the larger laboratories. The division head has under him a small number of men of considerable experience and proven ability who are the immediate supervisors for the remainder of the laboratory personnel. It is with these men, often called group leaders, that the actual day-to-day responsibility for project administration lies and probably the bulk of the original thinking involved in industrial research is found.

It should not be inferred that this type of organization is found uniformly throughout the field or is continuously adhered to by any one laboratory. Research laboratory organization is probably less formal than that of any other section of the company and the pattern is often not immediately apparent to an observer. Any of the functions described above may be omitted or expanded to fit the size of the laboratory and the situation of a particular company. In some instances the group leaders are omitted and the laboratory work is supervised directly by the laboratory head. The group system, however, is probably much the most common and is generally thought to make the most effective use of the knowledge, skill and originality found in the laboratory's experienced workers.

In addition to the "line" organization described above, there are a number of "staff" units, which will vary in number and purpose with the needs of the laboratory. These include the library and information service, the patent department, the financial organization, purchasing, stenography, drafting, apparatus construction, editorial work and publicity, and perhaps specialized technical personnel, such as mathematicians, which will serve as consultants for the other laboratory workers rather than engage directly in project work. The organization and direction of these units is a matter of considerable importance to the laboratory director but they do not constitute management problems for the other members of the "line" organization and will not be further discussed here.

Organizing the Project

Once a project has been selected for laboratory investigation (the question of project selection is an important problem in itself), the laboratory director sets about organizing the job so as to attain the prescribed objective. The project will usually fall naturally to a particular division and group leader because of the particular specialized skill that it calls for, although the availability of personnel and the wisdom of having a fresh viewpoint on the subject will of course modify the assignment. This assignment, as well as that of the personnel under the group leader, will usually be made by the research director and the division head, since it involves fitting the project in with the others then under way in the laboratory.

Along with the assignment of personnel, the research director together with the group leader assigned to the project ordinarily plans and schedules the work so far as is possible with an unpredictable operation such as a research project. The planning at this stage consists principally of breaking the job down into steps which on completion will permit a periodic review to determine the advisability of continuing the project, and the assignment of time schedules to these steps. These plans must be made with an eye to future modification and they must not be so restrictive as to kill the group leader's initiative or to prevent the profitable branching out of the investigation beyond its original objective. Nevertheless this "administrative planning" forms one of the most vital aspects of research management and the active participation of the research director or other administrative official is essential. It is the task of research management to clean up a project instead of perpetuating it. No project is ever finished in the sense that nothing more can be done on it; yet in order to accomplish anything useful, projects must at some time be terminated, either in abandonment or commercialization. So far as the laboratory is concerned, this decision rests with the research director and he is greatly aided in his decision by an arrangement of the work which will bring the project up for review at logical stages in its progress.

Commonly the first step in carrying out the project itself is a conference of all those who can contribute, including the research director, representatives of the sales and production departments if these have a particular interest in the project, any of the laboratory workers who are informed on the subject but will not be working on the project, and the group leader. The conference is conducted for the benefit of the group leader, to clarify the objective of the problem to him, to inform him of any limitations on the solutions he may offer, and to give him the advantage of the organization's knowledge of the subject.

The group leader next does some quiet thinking on the problem, he redefines the objective in his own terms so that he thoroughly understands it, and considers the alternative methods of attack in terms of the facilities available, both human and physical. At this point he may discuss the problem with his assistants and outline to them the objectives and the contemplated procedures, although some preliminary work by the group leader alone may be necessary before any larger staff is required. With the objective clearly in

(*Continued on page 64*)

A laboratory-scale, high-temperature reaction tube

Arthur D. Little, Inc.

KILOWATTS MEAN CHEMICAL PRODUCTION

NEW ELECTRICAL DEVELOPMENTS IN THE CHEMICAL INDUSTRY MAKE IT ONE OF THE COUNTRY'S LARGEST USERS OF ELECTRICAL POWER

By T. R. RHEA '24

T. R. Rhea was born in Bonham, Texas. In 1917 he enlisted in the United States Army, spent about six months at Texas A. and M. College as part of his training for service overseas, and then went to France with the A.E.F. After World War I he returned to the United States and attended Tulane University for two years, although he never had been to high school. Mr. Rhea then came to the Institute and was graduated in 1924 with the B.S. degree in electrical engineering.
In June, 1924 he entered the employ of the General Electric Company at Schenectady. Since that time he has worked in the Aeronautical, Marine, and Industrial Engineering Departments of that company. In 1929 he received a Master of Science degree in electrical engineering from Union College. He holds several patents, most of them concerned with application of electrical equipment to steel mills.

THE chemical industry may be subdivided into the following very broad divisions for convenience of discussion:

a. Electrochemical process — such as aluminum, magnesium, chlorine, and copper and zinc, which are the "Big Four," in the order named, from the point of view of d-c kilowatt capacity installed.

b. Electrothermal process for high temperature chemistry — such as magnesium, ferro-silicon, phosphorus, calcium carbide, and carbon.

c. Chemical process plants, which, for example, make heavy chemicals from raw materials, such as sulphuric acid from sulphur, or even such border-line cases as making alumina from bauxite.

d. Petroleum refining — considered one of the major chemical industries and destined to become an even more important factor in the chemical world as a source of hydrocarbons.

e. Synthetic rubbers, or "elastomers," which are closely allied in one phase of their production to the refining industry.

There are, of course, a large number of border-line industries and processes, which makes the chemical industry peculiarly hard to define and limit. For example, the blast furnace and the arc furnace for steel melting are outstanding examples of high-temperature chemistry; but they are so closely identified with the steel industry that they have been automatically placed in that category.

Electrochemical Processes

The years 1941 and 1942 were the outstanding years of all time for this industry in the number of new kilowatts of conversion apparatus installed to produce the wartime demand for aluminum, magnesium, chlorine, and copper and zinc. In each of these years, conversion apparatus totalling approximately 1,000,000 kilowatts was installed to convert alternating-current to direct-current.

This conversion apparatus included all types and makes, but mercury-arc rectifiers of the ignitron type predominated. In only a few special cases was rotating apparatus installed. Mercury-arc rectifiers are eminently suited to this industry because of their high efficiency and general all-around satisfactory performance.

These two record years, 1941 and 1942, brought the grand total of d-c kilowatts installed in the electrochemical industry to approximately 3,900,000 kilowatts. Of this grand total, 73 per cent are in mercury-arc rectifiers.

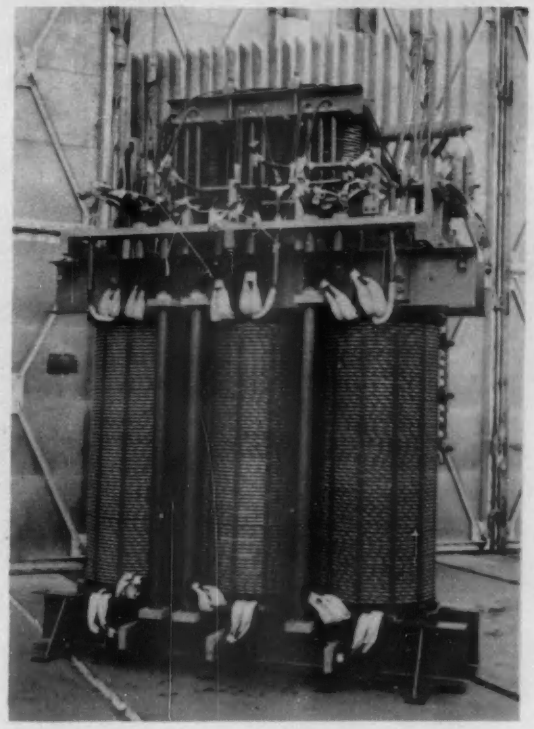
Because of the very high load-factor, the electrochemical processes will be absorbing energy at the rate of approximately 30,000,000,000 kilowatt-hours per year by early 1943 when all of the new apparatus is in full production. This energy consumption rate ranges from 12 to 15 per cent of all the electrical energy consumed in the United States, and is the largest single item of electrical load.

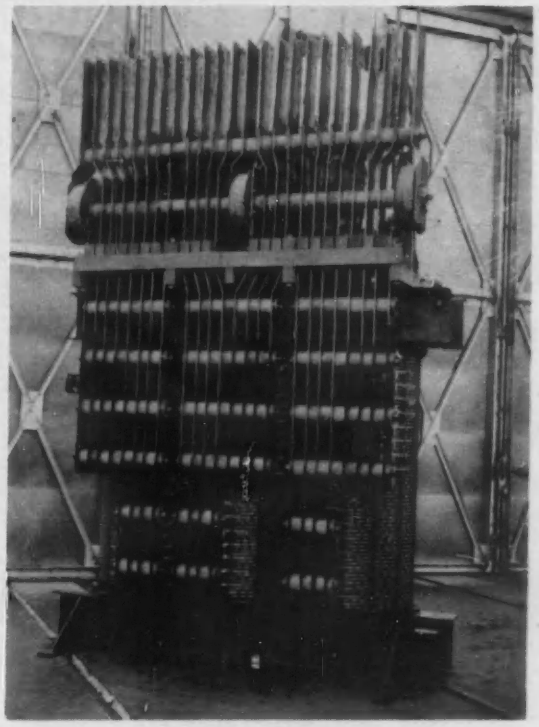
These figures are for the United States only, and do not include the 1,000,000 or so kilowatts installed in the Canadian electrochemical industry.

Nearly all of the mercury-arc rectifiers installed in 1941 and 1942 were equipped with high-speed anode breakers. These breakers, described in recent technical papers, are installed between the rectifier transformer terminal and the anode of the rectifier. There is one independently operated pole of the breaker for each anode.

When a rectifier arcs back, a short circuit is established on both the a-c system and the d-c system. The high-speed anode breaker removes this disturbance from both systems in one-half cycle or less, with no damage to the apparatus and without interrupting the power flow to the process (when several rectifiers supply the process).

The development and widespread use of these high-speed anode breakers is considered to be one of the





General Electric Company

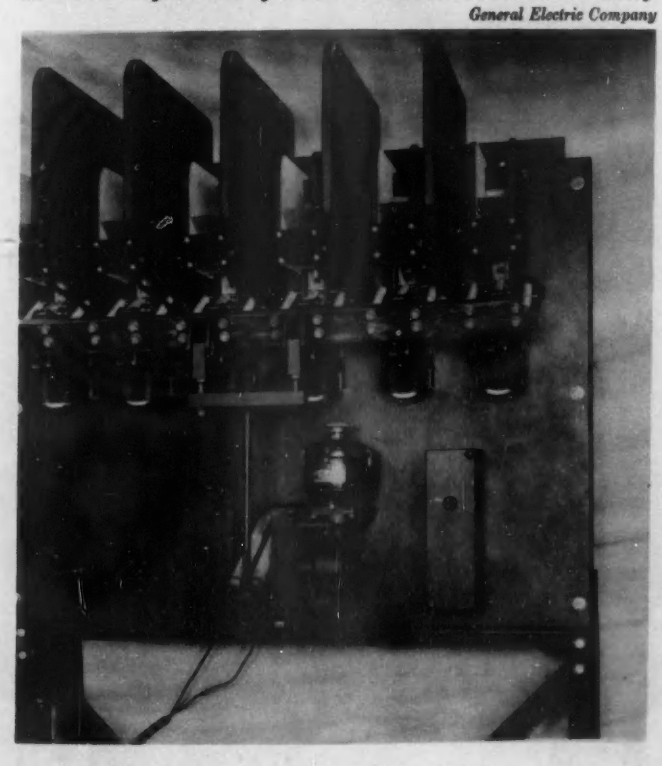
Core and coils for large furnace transformer for electrothermal production of ferro-silicon and magnesium

major developments in the industry. This can be readily understood when we consider the experience of a large chlorine "pot line" installed early in 1942. The effectiveness of the high-speed anode breakers on this installation has been such that since the "pot line" went into operation there has not been a single interruption of power flow to the "pot line" caused by arc back.

A particularly interesting application of mercury-arc rectifiers made in 1942 consisted of supplementing each of eight old 10-000-ampere rotary converters with a 3,000-ampere mercury-arc rectifier. The combination of 13,000 amperes at 589 volts resulted in a considerable increased output of electrolytic zinc. A special automatic current control on the rectifier permits them to parallel successfully with the rotary converters.

New high-speed, six-pole anode air circuit breaker for use with mercury-arc rectifiers in the electrochemical industry

General Electric Company



1942 saw an increased use of load-ratio-control autotransformers in the electrochemical industry for obtaining a wide range of d-c voltage adjustment on the rectifiers supplying "pot lines." These autotransformers permit the application of a wide range of d-c voltage to the "pot line" by tap changing under load. This is particularly desirable in the operation of magnesium "pot lines" where it may be desirable to start with only one or two cells and add cells gradually. Several such applications permit d-c voltage adjustment under load from zero to full voltage, and eliminate entirely the undesirable effects of grid control on the rectifiers themselves.

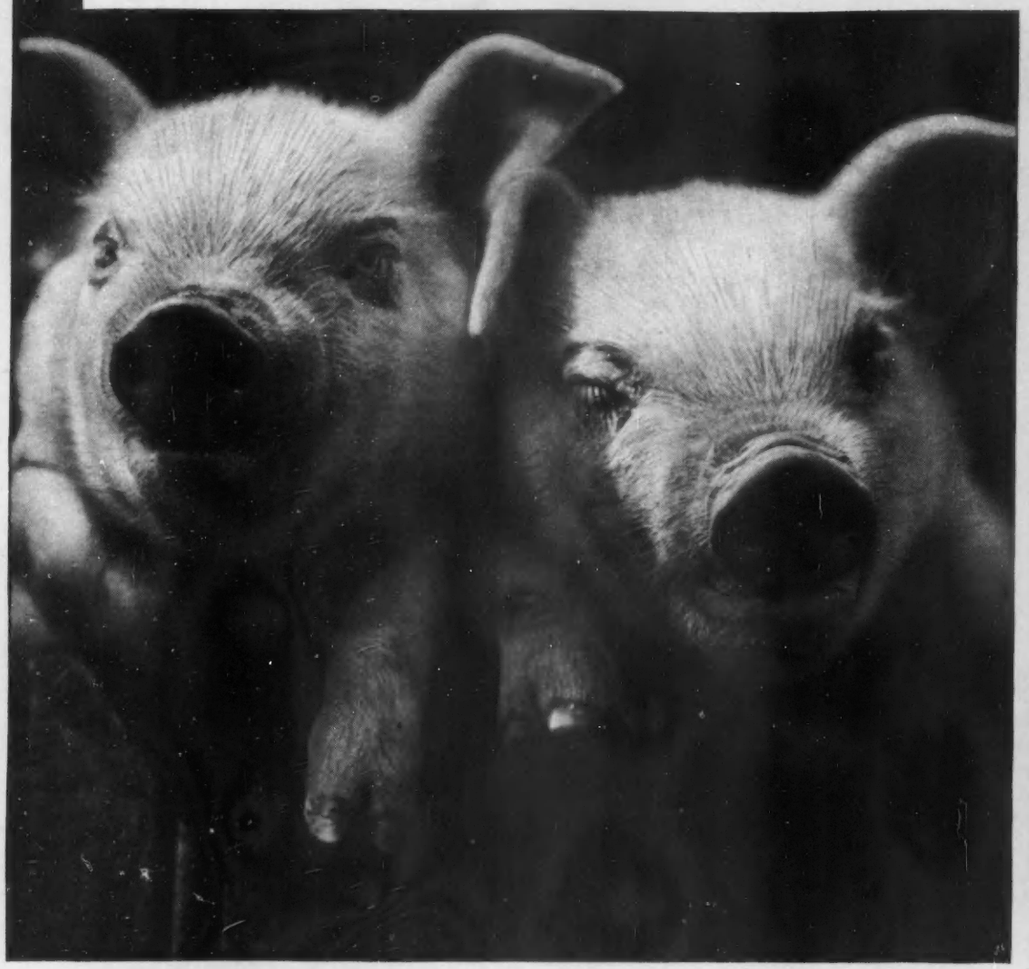
About fifteen sealed ignitron rectifiers of the load-center unit-substation type of construction were applied to hydrogen and sodium perchlorate electrolytic cell lines during 1942. The sizes of these rectifiers ranged from 200 to 500 kilowatts at 250 volts d-c. The sealed ignitron rectifier is sealed at the factory, and does not require continuous evacuation, as do the larger ratings of rectifiers.

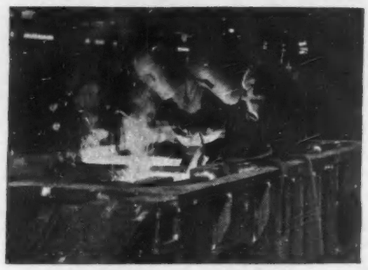
The unit-substation type of construction — where a-c switchgear, rectifier-transformer, rectifier, and d-c switchgear are combined as a complete factory-assembled unit — was borrowed from general industrial power distribution practice.

The general shortage of motor-generator sets and consequent long shipments led to the wide use of unit-substation type sealed ignitron rectifiers for general industrial applications, such as supplying the small amount of d-c power necessary for cranes and other machines.

The unit-substation construction for sealed ignitron rectifiers has become so convenient from the purchase and installation standpoints, that it will remain after the war on its own merits, both for electrochemical and general industrial applications. (*Continued on page 66*)

Fatter Porkers...Faster





A-C Welders now work exclusively on machinery for the war effort.

ALLIS-CHALMERS FARM and milling equipment helps produce corn for U.S. porkers and steers . . . wheat for 8 of every 10 bread loaves produced in the U. S. A.

Allis-Chalmers *industrial* equipment (more than 1,600 different capital goods products) works in every war industry . . . helps produce planes, tanks, ships, guns at a rate which must make Hitler shiver!

And Allis-Chalmers engineers—cooperating with plant engineers in every part of the country—are helping manufacturers *produce more*—not just with new machines, but *with machines now on hand!*

Every Allis-Chalmers man and woman is working *all out* for Victory. Our one job right now is winning this war. But from this war work we are gaining rich production experience which will be invaluable to the Nation when the war is over. We'll be ready to help build a better peace!

ALLIS-CHALMERS MFG. CO., MILWAUKEE, WIS.

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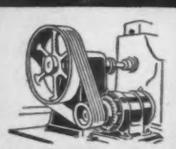
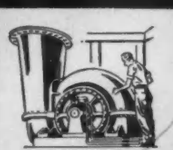
OFFERS EVERY MANUFACTURER EQUIPMENT AND ENGINEERING CO-

ELECTRICAL EQUIPMENT

STEAM AND HYDRAULIC TURBINES



MOTORS & TEXROPE V-BELT DRIVES



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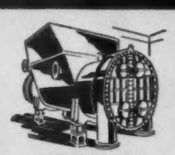

ENGINES AND CONDENSERS

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Planes

...ALLIS-CHALMERS HELPS MAKE BOTH!

Allis-Chalmers makes the greatest variety of capital goods products in the world.

Rubber boats, tires, balloons are made with the aid of Allis-Chalmers equipment.

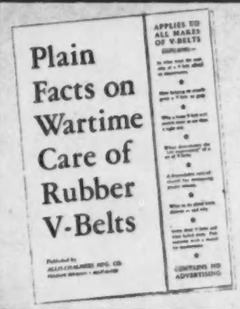
VICTORY NEWS

Inland Shipyards: Hundreds of A-C pumps, motors and V-belt drives are at work along the Great Lakes helping in the greatest shipbuilding activity this region has ever known.

Ore carriers, tankers, cargo vessels—even submarines—are being built here.

Tremendous expansion of facilities was required to meet the goals set—and equipment for the yards, as well as for the ships, has left A-C plants in great quantities.

YOU'LL WANT THIS HANDBOOK



FREE!
Contains No Advertising

New 16-Page Book applies to all makes of V-belts—tells how to conserve rubber through correct V-belt maintenance: how to measure proper tension; what determines "life expectancy"; what to do about worn sheaves; much other useful information. Liberally illustrated. Ideal for training new men. Write for your free copy.

New A-C War Plants: Two big new Allis-Chalmers war plants are now in operation "somewhere in the USA"...the second in a record 90 days after the ground was broken.

To save time and critical materials, wood construction was adopted for the newest plant. Practically the only metal used was in caps for the ends of trusses and columns. These were cast in A-C foundries to save time.

FOR VICTORY
Buy United States War Bonds

ALMERS

WE WORK FOR VICTORY — WE PLAN FOR PEACE

CO-OPERATION TO HELP INCREASE PRODUCTION IN THESE FIELDS...

FLOUR AND SAW MILL EQUIPMENT

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FRANKLY SPEAKING...

"The peace to come will be just as worthy of a supreme effort as the war is now." Those words of Henry Agard Wallace, the Vice-President, carry a message which is well for all Americans to ponder seriously, and immediately, for as he points out, "Peace unplanned could be a disaster worse than war."

Many political leaders have been speaking their minds on the subject recently, most in vague terms of "capital," "labor," "socialization," and "socialism"; some few far-sighted ones in terms of concrete proposals for international government and international economy. The governmental problems are more or less familiar, but the scope of the economic readjustment which must follow the war is such that it is not easily grasped.

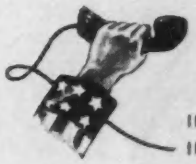
Consider the problem of the United States alone. In the next fiscal year government spending will exceed the sum of one hundred billion dollars. The figure is beyond comprehension; and so would be any comparison that might be made, even in terms of weight of gold, or even the weight of the paper it would take to print that amount in small bills! And what of the day of peace when this prodigious spending will cease? Almost ninety per cent of this amount is being spent for war material, which will no longer be required; a sudden cancellation of orders would result in a mass unemployment more calamitous than that of the 'thirties. The demand for articles not now in production, so-called "consumer goods," will undoubtedly be great, but no one will be in a position to supply that demand, for those commodities are not now in production, and just as it took months of time and billions of dollars to convert to war production, so it will take months and billions to reconvert. Where are those billions to come from? Private capital, now laboring under the burden of heavy taxes and restricted profits, made necessary by the war, will not be in a position to provide it. Distasteful as the prospect may seem to the "rugged individualists" and "economic royalists," the only source available will be the government, or government financed lending corporations. Yet that only provides the capital for the conversion; who will employ the ten to fifteen millions now in the armed services until industry is prepared to absorb them? To what better purpose could they be temporarily employed than to keep them in the army, not a fighting army, but an army of construction, yes, of construction — and of reconstruction, for who can deny that half a world in shambles will need rebuilding?

Thus, then, is seen the possibility of solving one of America's most pressing domestic problems, and at the same time laying the groundwork of the international order to come, by rebuilding the cities and homes of the ravaged continents, replanting the fields that will feed the starving populations of war-torn countries, and constructing the great international ports and airports which will sustain the greatly increased commerce of the future. Then, as this work is completed, men could be slowly absorbed by the greatly expanding industry at home, an industry which would be the supplier to the world for many years to come of products fabricated from the world-wide wealth of raw materials which would be at the disposal of all.

Perhaps not precisely by this plan, but certainly by some plan, carefully worked out beforehand, the way must be made ready to avert the calamity which will certainly accompany the day of peace, if we find ourselves unprepared for it.

Every branch of the Armed Services uses the telephone. No. 1 of a series, Anti-Aircraft.

To his mother and dad it seems only yesterday that he was using the family telephone to call his high school sweetheart. But today the orders he sends and receives over his wartime telephone help speed the day when love and laughter, peace and progress shall again rule the world.



Western Electric

IN PEACE...SOURCE OF SUPPLY FOR THE BELL SYSTEM
IN WAR...ARSENAL OF COMMUNICATIONS EQUIPMENT

ALUMNI MOVE AHEAD

Charles T. Cosser, working in the Middle East, was praised by Col. C. M. McGuire, United States Army Air Forces, for his technical efficiency "despite lack of much needed equipment and difficult maintenance conditions" with a bombardment group where "most missions are long, high altitude flights depending entirely on efficient supercharger operation for success."

Brig. Gen. V. H. Strahm, United States Army Air Forces, concurs in the commendation of Mr. Cosser as follows: "Due to his ability and initiative in both the maintenance of superchargers and the instruction of personnel in their operation, no difficulties have been experienced with this equipment."

Mr. Cosser is a graduate of Tufts College in the Class of 1940 with a B.S. degree in Mechanical Engineering. During the summer of 1939 he attended the Institute to study heat and ventilating engine designs. After finishing college he was employed by the General Electric Company in the Industrial Engineering Department at Lynn.

PROJECT ADMINISTRATION

(*Continued from page 57*)

mind a marshalling of existing knowledge applicable to the problem, both from the literature and from the experience of other members of the laboratory, is in order. The extensiveness of the literature search, which may be performed by the assistants, will of course depend on the nature of the problem.

A Typical Project

The progress of the work from this point on can best be visualized through description of an actual project. There is of course wide variation in procedure, depending on the type of problem and the degree of success encountered in the work. The example given below is typical of a sequence of events commonly encountered, although most research projects are less straightforward and involve more changes in mode of attack as the approaches first chosen are found unsuccessful. Furthermore, there are a number of different kinds of research objectives, including new-product development, use development, by-product utilization and many others, each with its own characteristics. The example below concerns development of a new process for manufacturing an old product.

This project involved developing a superior process for the manufacture of a compound, which we will call AB. The process then used by the chemical plant was slow, cumbersome and wasteful of raw materials. Little thought had previously been given to the process, since AB was not a high-priced product, but in a review of plant operations it was decided that the process merited attention. The problem was given to a chemical engineer with a number of years' experience, and he was given the services of two recent chemical engineering graduates as assistants.

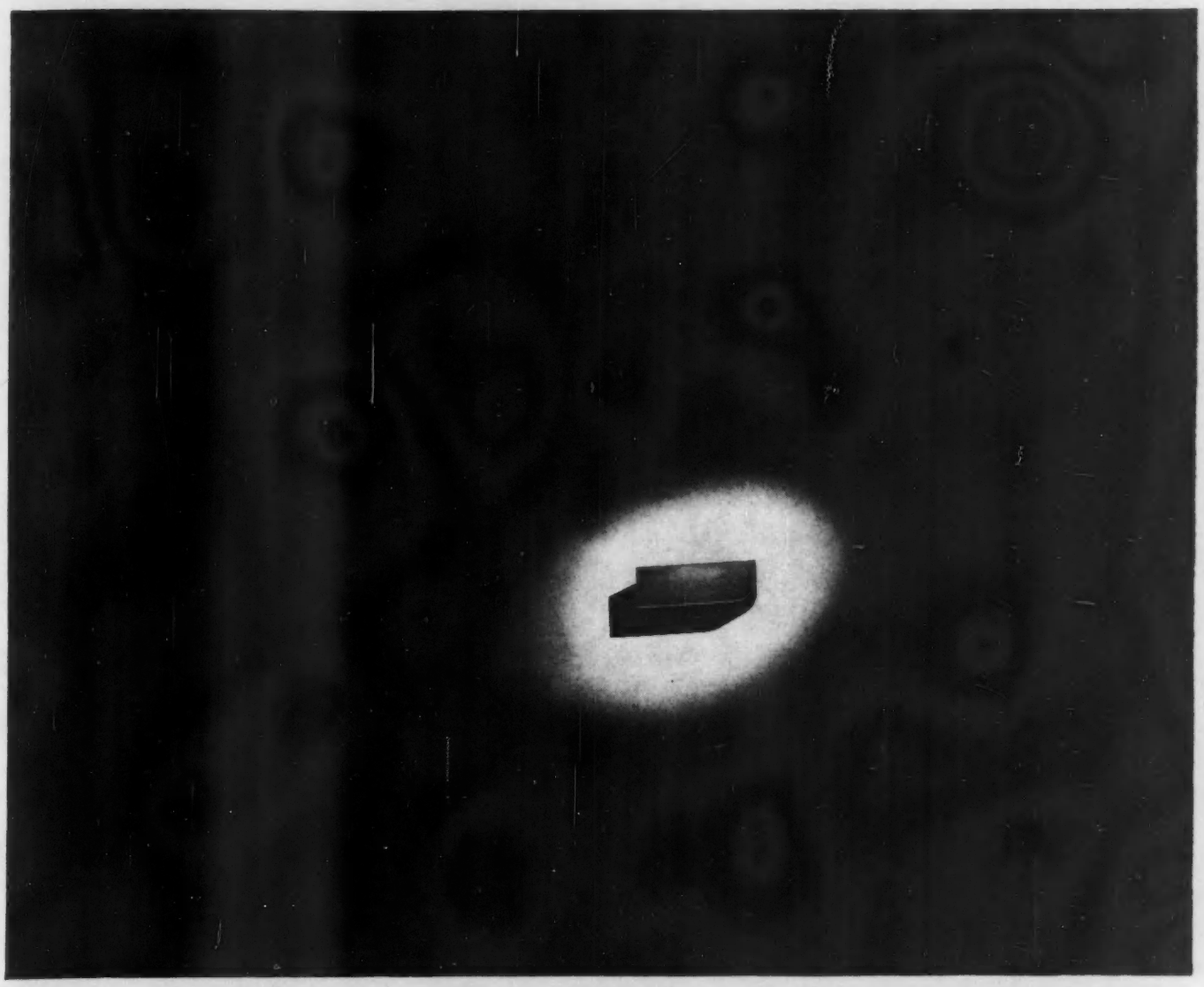
The first approach considered was the direct reaction of the substances A and B, which a crude cost calculation showed to be economically desirable. The group leader spent part of his time for about one month studying the thermodynamics of this reaction and the small amount of literature data available on it. He found through thermodynamic calculations that the reaction should take place at a high temperature, at which A was a solid and B a gas. However, B, a solid at normal temperatures, was very difficult to volatilize in a continuous apparatus. Two methods of avoiding this difficulty were investigated concurrently; one was the addition of a small proportion of a modifying agent to B, so as to decrease with the difficulty in volatilizing it, and the other was the use of a volatile compound of B. One of the assistants was then set to work for about two months on various additives. He was instructed by the group leader on the general type of additives to be tested, the nature of the tests to be performed and the criteria of effectiveness. At the same time the group leader investigated through the literature and by thermodynamic calculations the volatile compounds of B which might be used. He found that only one, BC, gave promise of success. He also studied, without laboratory work, the volatile compounds of A and decided that A itself was preferable. This study, concurrent with that of the modifying agents, took about two months.

The group leader decided to proceed with laboratory study of the reaction between A and BC. He designed a laboratory-size apparatus in which the reaction took place in a quartz tube at a high temperature. The two assistants built this apparatus and operated it for several months, varying all possible factors so as to learn the optimum conditions for operation. From time to time the apparatus was altered to permit more precise measurements.

The results of the trial runs were so successful that attention was turned to materials for construction of a commercial plant, the materials first to be used in a laboratory pilot plant. A chemical engineer with some experience with this type of reaction was added to the group at this time. The investigation of construction materials was favorable on paper, so the pilot plant was designed and built. It used the materials which would ultimately be used in a commercial plant except in the reaction tube, which was again constructed of quartz. Since the pilot plant operated successfully, other materials were investigated for use in the reaction tube. A satisfactory tube material was found and attention turned to building a semi-commercial unit in the plant. These pilot plant operations required about six months.

The entire group coöperated in designating the materials, general dimensions and arrangements of the parts of the semi-commercial plant; the company's engineering staff, not a part of the laboratory, drew up the detailed plans. When completed, the plant was operated continuously by three men, one of them an engineer, on each shift. The laboratory men did not take part in operating the plant, but were available for consultation. This semi-commercial plant did not operate successfully because of numerous mechanical failures, caused basically by difficult engineering problems inherent in the properties of the chemically resistant. Solution of these problems required a separate research program which was successfully carried through in

(*Continued on page 70*)



"METALLIC VITAMINS" FOR INDUSTRY

So effective are relatively minute quantities of cemented carbides in stepping up—pepping up—production that they are often called the "metallic vitamins" of industry.

Because only small quantities are required per tool, Carboloy cemented carbides are measured in grams. A gram is 1/453rd part of a pound. A Carboloy tool tip weighing only 25 grams or slightly less than one *ounce* is a good size tip—enough to last for days, weeks—often months of cutting at speeds often higher than 4 to 5 times that possible with ordinary steel tools.

In terms of production, an ounce of cemented carbide can turn the turrets of dozens of tanks, or drill hundreds of guns, or turn as many as several hundred shell, or bore the cylinders of hundreds of "Jeep" cars. One ounce of carbide can do these and countless other crucial machining jobs faster and better than any other tool material.

These "metallic vitamins" also serve the cause of victory in many other ways. In masonry drills, they drill holes in concrete 75% faster for installing war production machinery. . . . In dies they speed up production of wire, cartridge cases, bullets, etc. . . . As wear-resistant inserts on vital machine parts, they keep machines running. As a matrix material, they conserve diamonds, shorten operating time on mine drilling, dressing of grinding wheels, etc.

The myriad of present uses for Carboloy—the "metallic vitamin" of industry—now helping to speed the day of victory, forecast the steadily increasing diversity of benefits for the years of peace to come. ★ ★ Carboloy Company, Inc., Detroit, Mich. District Offices: Birmingham, Ala. • Chicago • Cleveland • Los Angeles • Newark • Philadelphia • Pittsburgh • Seattle.

CARBOLOY TRAINING FILMS

A series of six Carboloy Training Films now available covering detailed, step-by-step procedure on the design, brazing, grinding, use and manufacture of cemented carbide tools, 35 mm silent slide films. (Not motion pictures.) Available for permanent use at approximate print cost of $20 per set. Educational institutions may also secure sets on loan for single showings through selected college film loan libraries. Catalog and loan library listing on request. Write Carboloy Company Inc., Detroit, for Booklet "A".

CARBOLOY
TRADEMARK

CEMENTED CARBIDE
TOOLS • DIES • DRESSERS
MASONRY DRILLS • WEAR PARTS

KILOWATTS

(*Continued from page 59*)

Electrothermal Processes

Because of the diversity of this industry, it is difficult to give any statistical data on the additional kilowatt capacity of arc, resistance, and distillation furnaces installed in 1942. A large amount of kilowatt capacity was installed for producing magnesium by the ferro-silicon process, as discussed in recent technical literature.

One of the principal installations for producing magnesium by this process was made at a Pacific Coast plant which is already producing magnesium. This installation has a total installed capacity of approximately 60,000 kilowatts in furnace transformers for thermal distillation of magnesium by this process.

A ferro-silicon plant of about 37,500 kilowatts in furnace capacity is being built in the East for the purpose.

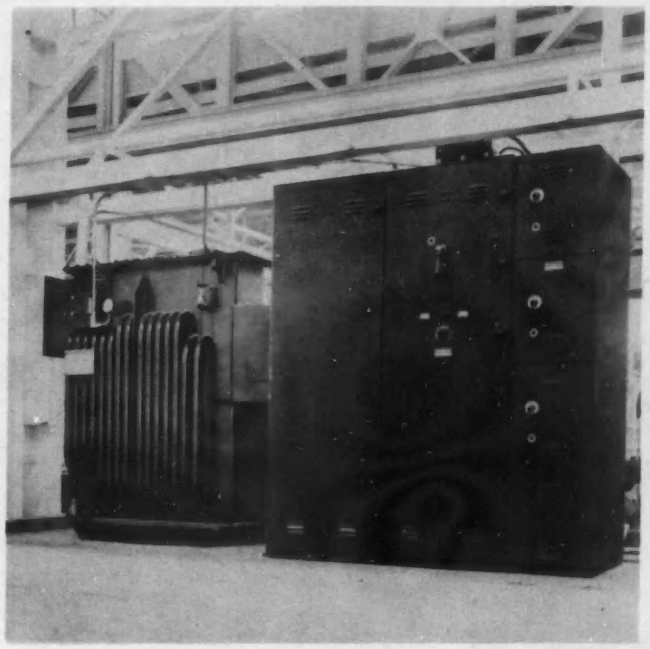
Petroleum and Synthetic Rubber Processes

During 1942 two additional gas turbines were manufactured to reclaim energy from natural gas that is burned in a carbon black plant, bringing to four the total of gas turbines installed in the carbon black process. Each of these gas turbines receives 165,000 cubic feet per hour of natural gas at a temperature of 450 degrees Fahrenheit at 225 pound gage. These temperature and pressure conditions are accumulated during the process. The turbines discharge at five pound gage into the further process.

Each of these turbines reclaims 150 kilowatts of electric power that would otherwise be wasted. Therefore, although small, these units are considered of significance since they indicate very real possibilities for further application in the chemical and petroleum industries. These industries are pressure and temperature industries, and wherever gas is processed under temperature and pressure, there are possibilities for reclaiming energy in the form of electricity. Accordingly, it is logical to expect an increasing number of such applications in the very near future.

The gas turbine applications referred to above are quite distinct from power generation gas turbines. They are applied directly in the process where the gas or air

(*Continued on page 68*)



General Electric Company

Sealed ignitron rectifier of factory-assembled load-center unit-substation type, installed in large war plant, 300-kv, 250-v size

View of 40,000 kw of ignitron mercury-arc rectifiers in a large western electrochemical installation

General Electric Company

Your future is not forgotten

★ A MESSAGE TO MEN IN COLLEGE

There will be a future.

The very service you are being called upon to render to your country is assurance of that. We know the stuff you're made of, because we have watched two generations of college men join our ranks and grow with us.

And the materiel which we older men in industry are pouring out makes assurance doubly sure.

What kind of future will you have?

By chapter and verse, no one can recite *exactly*. But a lot of folks like us mean to see that Opportunity is going to be greater than any generation of young men has ever known.

Every hour of thinking time we can catch on the fly is devoted to that one aim. Here at Alcoa we call it Imagineering. We are letting our imagination soar, and ballasting it with engineering experience. Our purpose is to make aluminum make jobs where none ever existed before.

The exciting new uses we glimpse for Alcoa Aluminum are our part of the groundwork of the structure of peace you will come back to help to build.

Your chance is going to be the creative chance. The materials, the tools, the techniques, will be ready and waiting. Your imagination, your ingenuity, your courage to do, cannot, must not, fail to have their turn.

As man to man we say it, soberly: Your future is not forgotten.

A PARENTHETICAL ASIDE: FROM THE AUTOBIOGRAPHY OF

ALCOA ALUMINUM

• This message is printed by Aluminum Company of America to help people to understand *what we do* and *what sort of men* make aluminum grow in usefulness.

FOR Victory AND AFTER

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Our research to maintain and improve the quality of Simplex insulated wires and cables, under restrictions designed to save critical materials, is getting results that mean better insulated conductors for commercial use after the war.

Simplex Wire & Cable Co.
79 Sidney Street, Cambridge, Mass.

KILOWATTS

(*Continued from page 66*)

receives its temperature and pressure as part of the process, while power generation gas turbines create the pressure and temperature for the express purpose of generating power in competition with steam turbine power plants.

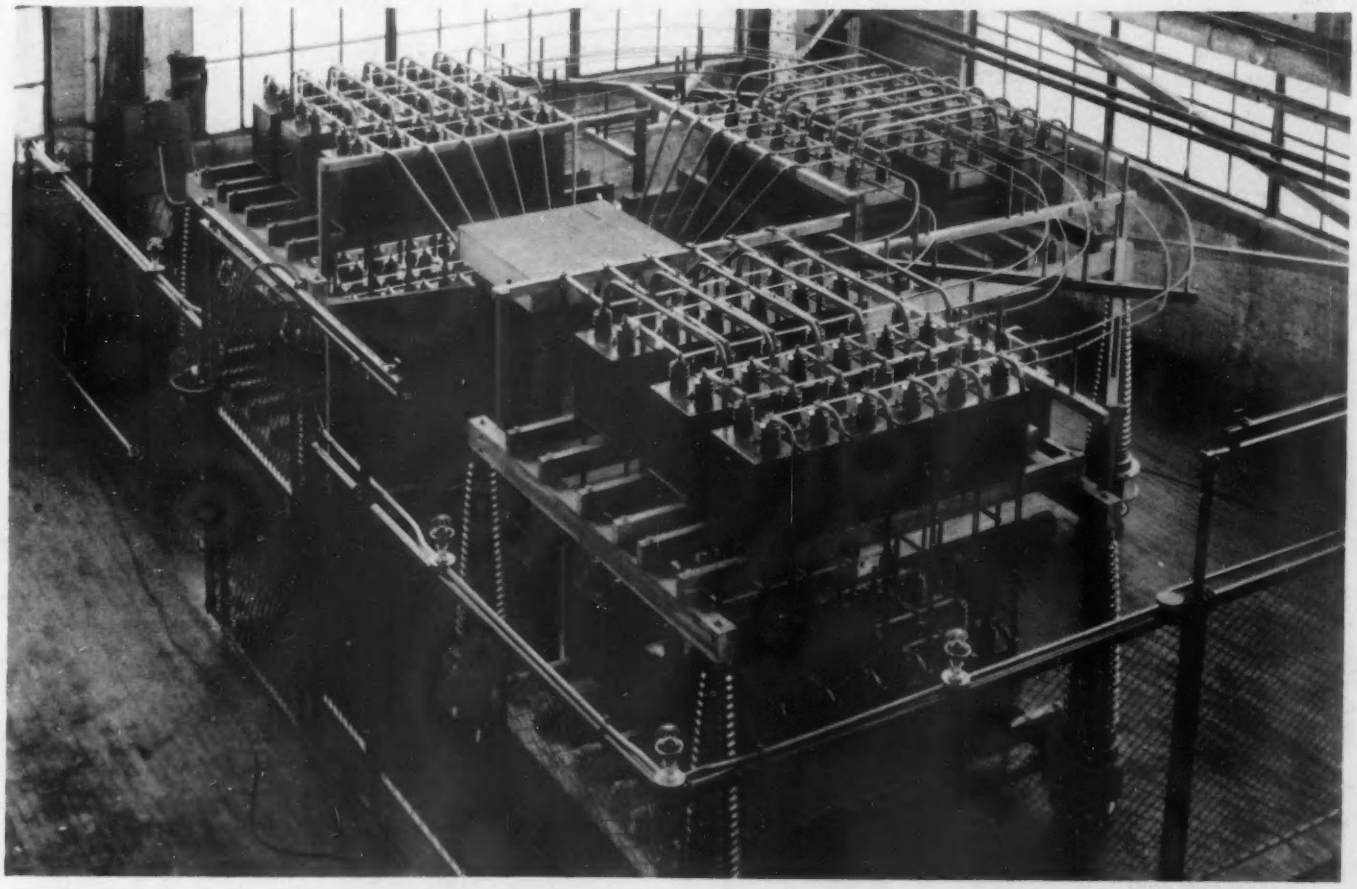
Some ten- or twelve-cycle automatic cycle timer control equipments were built and installed during 1942 in petroleum refineries and butadiene plants, and at least one found its way into a conventional chemical process. These cycle timers open or close a number of valves in a definite time sequence and keep repeating this sequence automatically. For example, in the "batch" process of catalytic cracking of gasoline, the catalyst may have to be rejuvenated once each hour or so by burning off the accumulated carbon with hot air while the gas steam is diverted through additional catalytic cases. The cycle timer controls these valves and has safety interlocking so that each valve operates in the correct sequence or is prevented from operating if some previous valve has failed to operate properly.

The advent of the continuous fluid catalyst and the moving-bed catalyst in the refining industry may eventually make unnecessary such valve operations; but, as noted before, these devices are now being applied to the new synthetic rubber industry and also to the chemical industry.

The 1,000,000 ton per year synthetic rubber, or "elastomer," industry, essentially a brand new creation of the year 1942, is expected to go into operation early in 1943. The Buna S synthetic rubber part of the program comprises about 75 per cent of the industry. This industry actually consists of four separate and distinct divisions:

(*Continued on page 72*)

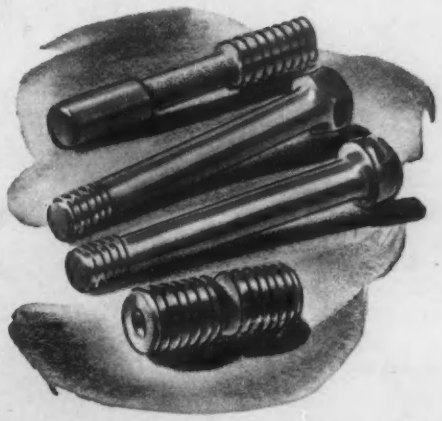
High voltage and multistroke generator *General Electric Company*

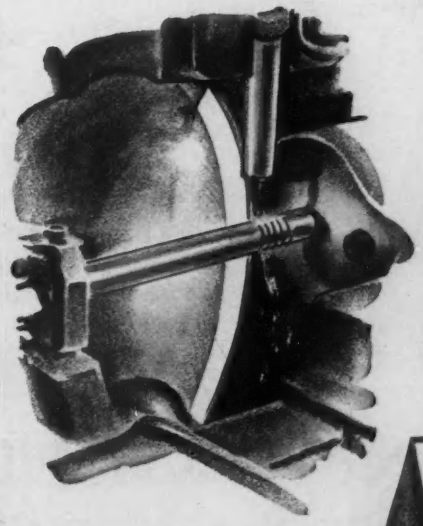


He flies a plane held together with threads!

At 400 m.p.h. a fighter pilot's life literally hangs by a thread. For the bolts and studs which help hold his engine and plane together are only as strong as their threads. Fortunately those threads can be counted on to hold. A special grinding process makes them far safer and stronger today than they would have been a few years ago. In this process, Carborundum-made grinding wheels play an important role.

The method of grinding produces threads of almost unbelievable accuracy, free from microscopic checks and cracks which might cause failure under stress. This greater accuracy justifies a smaller safety factor, reducing weight of dead metal. And in most cases, production is speeded and costs reduced.





Thread grinding is typical of the many ways in which products and processes developed by Carborundum are serving America's war industry. When you get out in the field and encounter a production problem that abrasives might solve, write The Carborundum Company, Niagara Falls, New York.

CARBORUNDUM
Reg. U.S. PAT. OFF. BRAND
ABRASIVE PRODUCTS

Carborundum is a registered trade-mark of and indicates manufacture by The Carborundum Company.

PROJECT

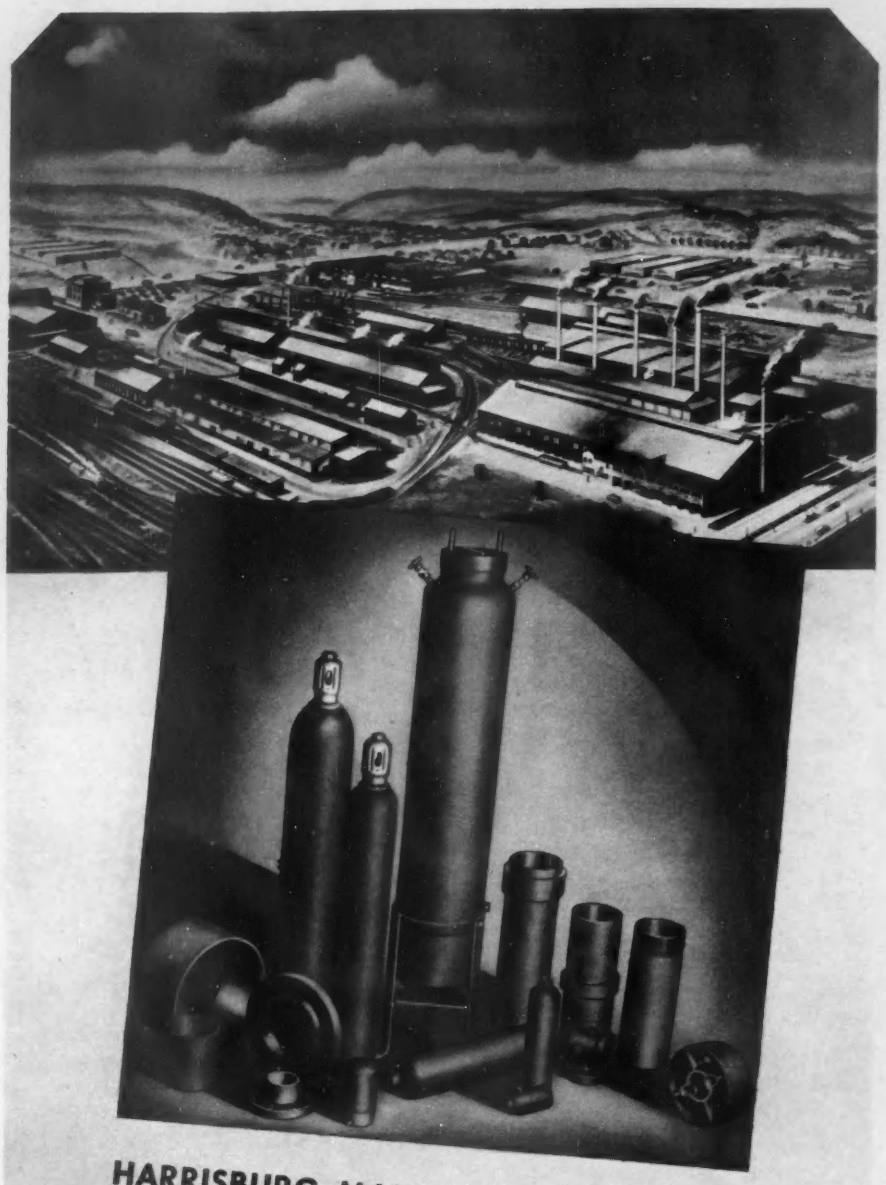
(*Continued from page 64*)

about two months time. The plant was then redesigned after about one year on the basis of information gained in its early operation and rebuilt. This second semi-commercial plant operated successfully and the laboratory's interest in the project was concluded.

Administering the Project

Throughout the course of a project such as the above the group leader bears the bulk of the primary responsibility for getting the work done on time, for selecting judiciously from the possible alternative procedures, for envisioning other alternatives when those tried have failed, and for the primary judgment on the wisdom of proceeding to another phase of the investigation, as from laboratory table to the pilot plant. However, all those engaged in the project must be encouraged to offer suggestions and opinions; many research directors have stated that one of their most important criteria in judging a young staff member is his self-reliance as evidenced by his ability to suggest ways out of the impasses into which research work so often leads.

During the project, managerial controls were exerted to attain two general objectives, the direction of the worker's efforts toward completion of the project and the direction of the course of the project so as to fit the needs of the company as a whole. The flow of effort and thought on the project was of course much less clear than is indicated by the abbreviated description above. All of those engaged worked from time to time on other projects of more immediate urgency and the group leader spent only a minor part of his time on this project. It was possible both that these other demands on the worker's time would delay the project to an extent incompatible with the objectives of the company (or that the incompetence of the workers would lead to the same difficulty) and that the scientific curiosity of those engaged on the project would lead it into directions not profitable within a reasonable length of time. These difficulties were avoided in the first instance by the selection of men, both for employment by the company and for assignment to the project, whose industriousness, self-reliance, and habits of thought fitted them to the work.



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What's so wonderful about it? Sapphire is necessary for the security of this country. Out of this jewel stone are made hard, long-wearing bearings for precision instruments. The various precision devices of a modern battleship require more than 4,000 jewels; about 100 more are needed in fire-control mechanisms. Modern pursuit planes and bombers require up to 100 sapphire bearings in their instruments.

In 1940, this country was completely dependent upon Europe for sapphire jewels. The call went out for American-made sapphire to meet this nation's needs.

Because we at Linde are experienced in the production of gases and in the accurate control of high temperature gas flames, we volunteered to try to make sapphire. After two years of experimental research, we learned how to produce the high-purity raw materials needed and also how to make sapphire from those materials. Today, we make more synthetic sapphire than this country ever imported from Europe . . . enough to meet all industrial and military needs. Thus America need never again be dependent upon an outside source.

Right now, we make colorless sapphire because colorless jewels make harder bearings. No sapphire is available for anything but war production. In the future we stand ready to make ruby and other gem stone materials for the jewelry trade . . . and for you.

This research development by The Linde Air Products Company is paralleled by other recent achievements of Electro Metallurgical Company, Carbide and Carbon Chemicals Corporation, and National Carbon Company, Inc.—all of which are Units of Union Carbide and Carbon Corporation.

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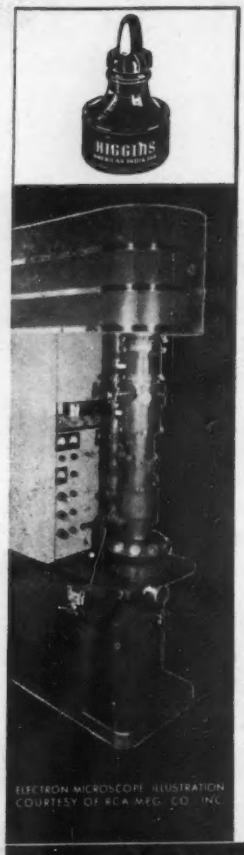

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KILOWATTS

(*Continued from page 68*)

1. Power houses for the generation of electric power and the very large quantities of process steam required.

2. Butadiene plants. These are very similar to refineries.

3. Styrene plants.

4. Polymerization plants where the raw materials, butadiene and styrene, are polymerized into Buna S type rubber.

The power plants now being installed in this industry include a 40,000 kilowatt steam turbine in a butadiene plant in the East, two 25,000 kilowatt steam turbines in a combination refinery and butadiene plant in the South, and a 35,000 kilowatt steam turbine in a butadiene plant in the Southwest. These power plant installations represent only those plants where it has been found feasible to skim electric power from the steam before sending it to the process. In a large part of the remainder of this industry, only low-pressure boilers will be installed and steam will go directly to process.

There are several hundred mechanical-drive turbines driving auxiliaries and pumps in several of these butadiene plants. Since the Rankin efficiency of the large 35,000 kilowatt turbine is about 80 per cent and that of the small 100 horsepower mechanical-drive turbine may be as low as 40 per cent, this means that the same steam allowed to expand in the large turbine to the final process pressure will produce something over twice the kilowatts or horsepower.

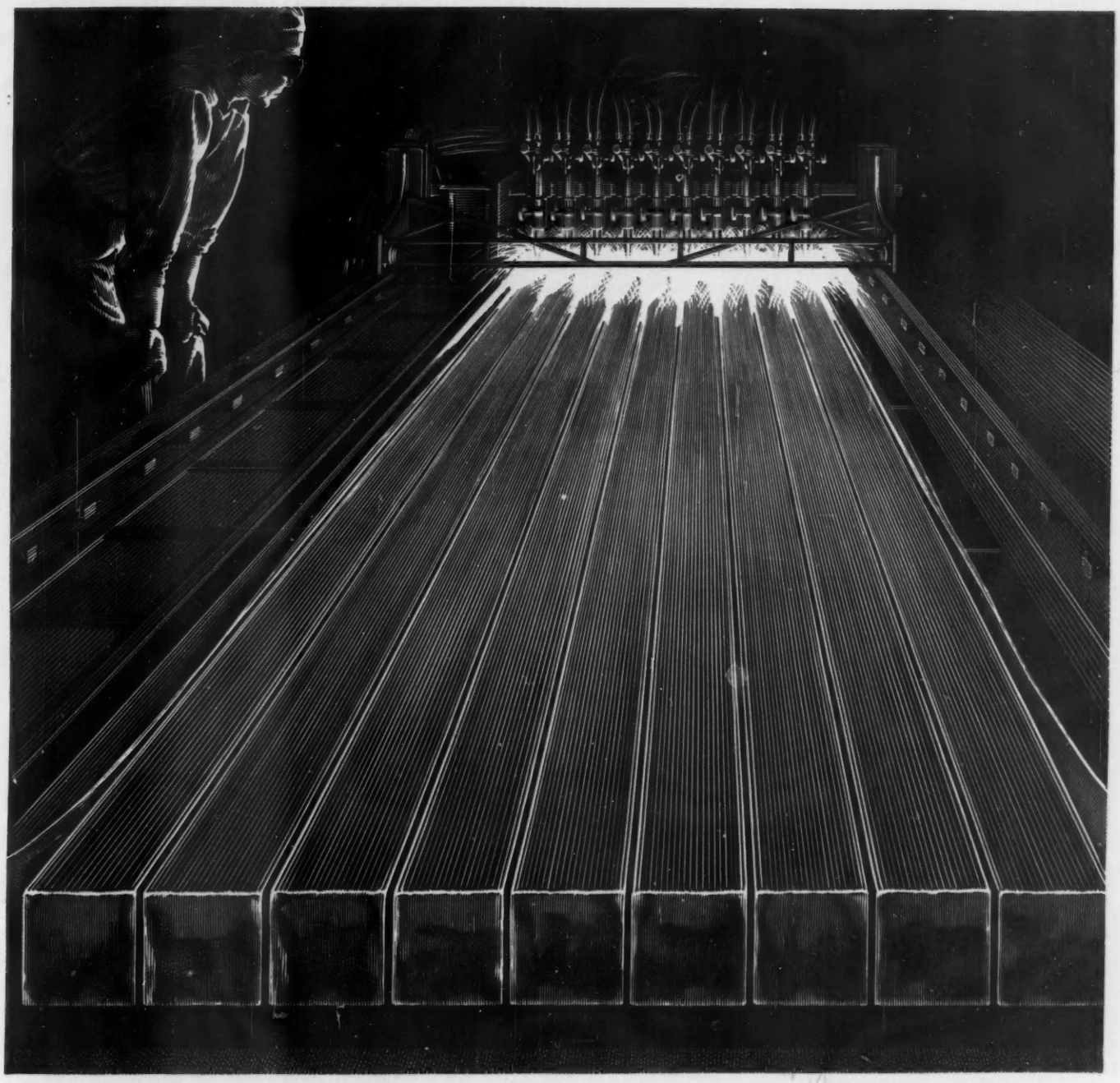
The widespread use of the small mechanical-drive turbine in these industries at this particular time requires an explanation since their use is exactly counter to the trend to use electric motors for such drives wherever possible. The principal reasons for their use are their availability and the saving of copper. Other reasons are ease of obtaining adjustable speeds and the requirements of 15 pound process steam in the immediate neighborhood of the drive.

These points are emphasized because of the unusual conditions prevailing. The installed cost of the small mechanical-drive turbine is approximately forty dollars per horsepower as against about thirty-five dollars per horsepower for electric motors where an electric distribution system already exists. In addition, about one horsepower is lost for each horsepower installed, due to the lower Rankin efficiency of mechanical-drive turbines. It is expected, therefore, that the trend to install electric motor drive will be resumed after the unusual conditions have passed.

About half of the kilowatts generated by the large synthetic rubber plants will be returned to the public utility systems, while the remainder will be used in adjoining butadiene and polymerization plants. In one case, at least, some of the process steam will go to a polymerization plant erected in conjunction with a butadiene plant.

Speed in erecting plants is more essential now than is obtaining the last B.T.U., but it can be expected that after the war considerable refinement along the lines of heat balance and heat utilization will take place in synthetic rubber plants.

In conclusion, it seems evident that the tremendous impetus given to the chemical industry by the war will have a profound and even revolutionary effect on industry when peace returns.



SLICING STEEL SLABS — and production schedules

STEEL billets were needed. Only slabs were available. That was the problem presented by expanded wartime demands which had to be licked, quickly. It was — by the process illustrated above. Ten oxyacetylene cutting torches, mounted on a frame propelled by two Airco Radiagraph machines, streak down the 140" steel slabs and slice them into billets.

It's one of the many examples of how American resourcefulness, teamed with specialized knowledge, is making minutes more productive. Oxyacetylene cutting and welding and the electric arc are blazing new trails to faster and better production in almost every war industry. The minutes, hours, even days of production being gained by these modern tools are now helping us to overcome our enemies' headstart.

If you work with metals you should know the complete story of the oxyacetylene flame and the electric arc—their speed, efficiency and broad range of usefulness in metal working. This knowledge is vital today—invaluable in the peace to come.

"Airco in the News" shows many interesting uses of the oxyacetylene flame and electric arc. Write for copy.

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G-E Campus News

MERRY-GO-WHEEL

A DEVICE that rotates in the manner of a combination merry-go-round and Ferris wheel has been developed to speed the drilling of marine gear casings at one of General Electric's major plants.

Known as a universal indexing trunnion fixture, the device permits quick moving of the casings for drilling at any angle in a full circle and on any plane. Movement is controlled by a push-button.

About 110 holes must be drilled and tapped in each of the casings. Formerly it took a crane to move the casings (which vary in weight from 1000 to 2000 lb) after each surface was drilled, and every piece of work had to be set up at least six times.

Now work is set up just once—on a table that can be turned completely around in either direction with no more effort than it takes to push a revolving door—and 24 to 32 hours a week are saved.

THE BETTER TO SEE WITH

PARTICLES as small as one millionth of an inch—one thousandth of the diameter of a human hair—can be clearly seen with the new G-E electron microscope.

Developed by Drs. C. H. Bachman (Iowa State, '32) and Simon Ramo (U. of Utah, '33), the new instrument can magnify a specimen as much as 10,000 times and reveal the actual composition and structure of such minute things as dust and smoke particles.

Here's how it works: a beam of electrons inside a vacuum chamber passes through the specimen, passes through an "electron lens," and produces a magnified picture on a fluorescent view screen. This image can then be photographed outside the tube and enlarged up to 100,000 times the size of the original specimen.

The microscope, designed for use in small laboratories and war plants, is portable and operates on ordinary house current.

THE LIGHT FANTASTIC

ACTUALLY it's just an ordinary light bulb, but used in an indicating method developed by a G-E foreman, it helps minimize errors in precision lathe work requiring an accuracy of five one hundred thousandths of an inch.

This new method eliminates the human element inherent in the old practice of using a magnifying glass to see when the tool makes contact with the surface to be cut.

In this indicating method, electrical contact between tool and work is used to close a light circuit. The tool is brought up to the surface to be cut in the regular manner until it is just about to make contact. From this point on it is brought up very slowly until the pilot light flickers.

When the light is steady, the indicator is set at zero; and if it is set and read correctly, there can be no error.

If you'd like to try this on your own machine-shop equipment, write for a free diagram and description to Campus News, General Electric Co., Schenectady, N. Y.

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